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Tests
D-2
Chem 3
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DEPARTMENT
EDUCATION ALBERTA

HIGH SCHOOL AND UNIVERSITY MATRICULATION
EXAMINATIONS BOARD

DEPARTMENTAL EXAMINATIONS, 1965

CHEMISTRY 30

Time—3 hours

DO NOT SPEND TOO MUCH TIME ON ANY ONE QUESTION.
READ THE DIRECTIONS FOR EACH QUESTION CAREFULLY.

Total Possible Mark—200

All your work must be done in this booklet.
Do not write your name on this booklet.

Mathematical tables may be used.
Slide rules are permitted.

Page 2A contains the Periodic Table. This page, for convenience, should be torn out for ready reference when required.

Rough work and diagrams may be done in pencil.
Finished work must be done in ink (blue or black).

In solutions to problems enough work must be shown to indicate the method used. Give numerical answers to the NEAREST TENTH unless otherwise indicated.
Include units.

DO NOT FOLD THE BOOKLET.

Place your test booklet in the answer envelope in such a way that the **UPPER LEFT HAND CORNER OF THE BOOKLET** (Candidate's Number) shows through the **SLASHED CORNER** of the answer envelope.

BE SURE TO SEAL THE ENVELOPE.

Atomic Weights

H	1.0	Cl	35.5	K	39.1
C	12.0	Mg	24.3	Na	23.0
Ca	40.0	N	14.0	O	16.0
				S	32.1

Gas constant, R = 0.0821 liters-atmospheres per degree-mole.

(For the use of Sub-Examiners only)

.30
HIST

Place the NUMBER corresponding to the best answer in the brackets to the right. Each correct answer has a value of 2 marks for questions 1 to 20 inclusive.

1. As a class, the substances with the lowest melting points are

(1) Molecular solids
(2) Ionic solids
(3) Covalent solids
(4) Metallic solids (..........)

2. The compounds found in gasoline are mainly

(1) carbohydrates
(2) hydrocarbons
(3) esters
(4) ketones (....4....)

3. One of the reasons that gases deviate from the ideal gas laws is that their molecules do have significant volumes. These deviations become more apparent at

(1) low pressures
(2) low density
(3) high temperatures
(4) high pressures (....4....)

4. The chemical properties of elements depend principally upon

(1) their atomic weight
(2) the composition of their nuclei
(3) the ratio in which the atoms combine with other atoms
(4) the number of electrons in their outermost shell (..........)

5. The names of salts of binary acids end in

(1) -ide
(2) -ic
(3) -ite
(4) -ate (..........)

6. The Avogadro number N, is 6.02×10^{23}. The atomic weight of magnesium is 24.3. One MOLE of magnesium weighs

(1) 24.3/N grams
(2) N/24.3 grams
(3) 24.3 N grams
(4) none of these (..........)

FOR ROUGH WORK

(No marks given for work in this space)

Page 2A
Tear this page out for ready reference when required.

PERIODIC TABLE

PERIOD	GROUP 1A	2A			TRANSITION ELEMENTS GROUP								GROUP 3A	4A	5A	6A	7A	GROUP 0
			3B	4B	5B	6B	7B	8B			1B	2B						
1											1 H 1.0							2 He 4.0
2	3 Li 6.9	4 Be 9.0											5 B 10.8	6 C 12.0	7 N 14.0	8 O 16.0	9 F 19.0	10 Ne 20.2
3	11 Na 23.0	12 Mg 24.3											13 Al 27.0	14 Si 28.1	15 P 31.0	16 S 32.1	17 Cl 35.5	18 Ar 39.9
4	19 K 39.1	20 Ca 40.1	21 Sc 45.0	22 Ti 47.9	23 V 50.9	24 Cr 52.0	25 Mn 54.9	26 Fe 55.8	27 Co 58.9	28 Ni 58.7	29 Cu 63.5	30 Zn 65.4	31 Ga 69.7	32 Ge 72.6	33 As 74.9	34 Se 79.0	35 Br 79.9	36 Kr 83.8
5	37 Rb 85.5	38 Sr 87.6	39 Y 88.9	40 Zr 91.2	41 Nb 92.9	42 Mo 95.9	43 Tc - - -	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57-71 See La Series	72 Hf 178.5	73 Ta 181.0	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (210)	85 At - - -	86 Rn (222)
7	87 Fr - - -	88 Ra 226.0	89-103 See Ac Series															

La Series	57 La 138.9	58 Ce 140.1	59 Pr 140.9	60 Nd 144.2	61 Pm - - -	62 Sm 150.4	63 Eu 152.0	64 Gd 157.3	65 Tb 158.9	66 Dy 162.5	67 Ho 164.9	68 Er 167.3	69 Tm 168.9	70 Yb 173.0	71 Lu 175.0
Ac Series	89 Ac (227)	90 Th 232.0	91 Pa (231)	92 U 238.0	93 Np —	94 Pu —	95 Am —	96 Cm —	97 Bk —	98 Cf —	99 Es —	100 Fm —	101 Md —	102 No —	103 Lw —

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7. The maximum number of electrons with a Principal Quantum Number of 2 is

(1) 32
(2) 2
(3) 8
(4) 18 (..........)

8. The statement that no two electrons in the same atom can have the same set of four quantum numbers is known as the

(1) Heisenberg Uncertainty Principle
(2) Pauli Exclusion Principle
(3) Periodic Law
(4) Brønsted Principle (..........)

9. The acid which dissolves glass is

(1) hydrochloric acid
(2) hydrofluoric acid
(3) phosphoric acid
(4) silicic acid (..........)

10. The mass spectromenter is an instrument used to study the charge-to-mass ratio of

(1) atomic spectra
(2) electrons
(3) positive particles
(4) bright-line spectra (..........)

11. Bromine should add most readily to

(1) $CH_3CH_2CH{=}CHCH_3$
(2) CH_3CH_2OH
(3) $CH_3CH_2OCH_2CH_3$
(4) $CH_3CH_2CH_2CH_2CH_2CH_3$ (..........)

12. An element has the electronic configuration of $1s^2\ 2s^2\ 2p^6\ 3s^1$. The symbol for this element is

(1) F
(2) K
(3) Mg
(4) Na (..........)

13. The only linear molecule among the following is

(1) H_2O
(2) NH_3
(3) CO_2
(4) HOCl (..........)

14. Which of the following pairs illustrates the law of multiple proportions?

(1) CO and CO_2
(2) CO and H_2CO
(3) O_2 and O_3
(4) H_2O and H_2S (..........)

FOR ROUGH WORK
(No marks given for work in this space)

15. Of the following atoms the smallest in volume is

(1) Cs
(2) Be
(3) Li
(4) Ca (............)

16. Of the following atoms the one of highest electronegativity is

(1) Cl
(2) Mn
(3) K
(4) Br (............)

17. Sodium sulphate, Na_2SO_4, is most soluble in

(1) C_6H_6
(2) C_2H_5OH
(3) CCl_4
(4) H_2O (............)

18. Substances such as stearin, which are the glyceryl esters of complex organic acids, are

(1) soaps
(2) fats
(3) aldehydes
(4) ketones (............)

19. An atom of one isotope of hydrogen consists of 1 proton, 2 neutrons and 1 electron. Its atomic mass in a.m.u. is

(1) 1
(2) 2
(3) 3
(4) none of these (............)

20. The Stern-Gerlach experiment is interpreted to mean that

(1) electrons have negative charge
(2) silver ions are positively charged
(3) the electron can spin in two directions
(4) silver has two isotopes (............)

FOR ROUGH WORK

(No marks given for work in this space)

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Values

15 **21.** Complete each of the following statements by writing an appropriate word or phrase in the space provided.

(a) The amount of charge transferred when a current of one ampere flows for one second is one ....

(b) Acids which furnish more than one proton per molecule are termed ....

(c) Bohr suggested that energy absorbed or emitted by atoms is restricted to certain values. It is said to be ....

(d) The energy necessary to remove an electron from an atom is the ....

(e) Alpha particles are fast-moving .... nuclei.

(f) Plants manufacture their food by a process called ....

(g) One .... is the charge on 6.02×10^{23} electrons.

(h) Changing one element into another is called ....

(i) A molecule possessing two centers of opposite electrical charge is called a ....

(j) The arrangement of atoms or ions in a crystal is known as a ....

(k) Elements formed by the filling of the "d" orbitals are called .... elements.

(l) CH_3CH_2OH and CH_3OCH_3 are called .... because they have the same molecular formula.

(m) The nucleus of the iron atom has thirty ....

(n) Sucrose and cellulose are examples of a class of compounds known as ....

(o) In the electrolysis of sodium chloride solution, chlorine gas is liberated at the ....

Values

4 **22.** A neutral atom of an element "Z" has two electrons in the K-shell, 8 in the L-shell, 8 in the M-shell and 1 in the N-shell.

(a) It has a total of .... "s" electrons.

(b) It has a total of .... "d" electrons.

(c) It has a total of .... "p" electrons.

(d) The formula of its simplest compound with oxygen is

....

3 **23.** Draw a cross-section through a "ls" orbital of a HYDROGEN ATOM, using shading to indicate probability density for the electron.

4 **24.** What is the oxidation number of chromium in each of the following:

(a) $Cr_2O_7^{-2}$ ....

(b) $Cr(OH)_3$ ....

(c) $CrO_4^=$ ....

(d) CrO_2Cl_2 ....

FOR ROUGH WORK

(No marks given for work in this space)

Values

3 **25.** (a) Indicate by a drawing the three dimensional representation of the shape of a methane molecule.

3 (b) Explain this shape in terms of the atomic orbitals of carbon.

....

....

....

....

....

8 **26.** Give the electron-dot formula (electronic formula) of each of the following ions or molecules:

Example: water H_2O,

$$\begin{array}{cc} \mathrm{H} & :\overset{\cdot\cdot}{\underset{\cdot\cdot}{\mathrm{O}}}: \\ & \mathrm{H} \end{array}$$

(a) ammonia NH_3

(b) propane C_3H_8

(c) ethylene C_2H_4

(d) chloride ion Cl^-

FOR ROUGH WORK

(No marks given for work in this space)

Values

10 **27.** Write balanced chemical equations for the following reactions:

(a) Silver chloride dissolves in excess ammonia solution.

(b) Disodium phosphate is added to a basic solution containing ammonia and magnesium ions.

(c) Barium chloride solution is added to a solution containing sodium bromide, potassium nitrate, and ammonium sulfate.

(d) Ethanol and acetic acid react to form ethyl acetate and water.

(e) Concentrated hydrochloric acid is added to manganese dioxide, and warmed.

4 **28.** Write balanced equations for the reactions in a lead storage battery during discharge

(a) at the anode.

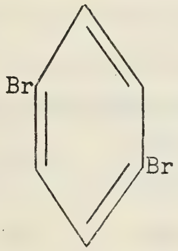
(b) at the cathode.

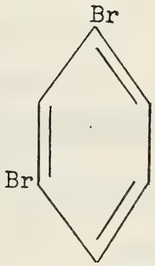
FOR ROUGH WORK

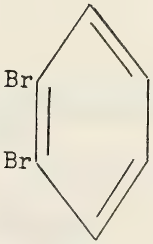
(No marks given for work in this space)

4 **29.** All six carbon-carbon bonds in the benzene molecule, C_6H_6, are equivalent. Explain.

3 **30.** (a) Name the following organic compounds for which the structural formulas are given.







(1) ....

(2) ....

(3) ....

4 (b) Two characteristics of organic reactions are their relative slowness and the fact that the greater part of the reacting molecule remains unaffected. Why are these useful features for organic chemists?

Values

3 **31.** Account for the fact that a typical transition element shows several different oxidation states.

3 **32.** Account for the fact that chromium metal retains a high polish for long periods.

7 **33.** List two types of polymerization reactions used in producing organic compounds. Give an example of each and discuss **one** type in some detail.

Values

4 **34.** The alkali metals are soft and ductile. Account for these properties in terms of the bonding involved.

10 **35.** Fill in the blanks in the following table

Refer to the Periodic Table on page 2A.

Element	Oxide Formula	Acid Base Properties	Typical Compound	
			Formula	Name
Mg	MgO	Basic	$MgCl_2$	Magnesium Chloride
Se				Sodium Selenate
Cs				Cesium Nitrate
Si			$SiCl_4$	
Re	—	—	Potassium Perrhenate	

FOR ROUGH WORK

(No marks given for work in this space)

Values

5 36. (a) Draw a diagram of a cell representing the electrolysis of molten NaCl. Label the anode and cathode. Show the directions of travel for the electrons and the ions present.

1 (b) Write an equation for the cathode reaction.

2 (c) Write an equation for the anode reaction.

1 (d) At which electrode does reduction occur?

FOR ROUGH WORK

(No marks given for work in this space)

Values

For questions numbered 37, 38, and 39 check (√) the correct answer. Show your work in the space to the left of the suggested answers.

4 **37.** 4.6 grams of metallic sodium reacts with water (in the absence of air), producing sodium hydroxide and hydrogen. How many moles of H_2 are produced?

(a) 0.10 moles (..........)

(b) 0.20 moles (..........)

(c) 0.40 moles (..........)

(d) 0.46 moles (..........)

(e) 0.50 moles (..........)

4 **38.** How many grams of KOH are contained in 500 ml. of a 3.0 M solution?

(a) 0.10 grams (..........)

(b) 0.30 grams (..........)

(c) 37 grams (..........)

(d) 84 grams (..........)

(e) 168 grams (..........)

4 **39.** What volume of 18 M H_2SO_4 is required to prepare 6 liters of 5 M solution?

(a) 0.9 liters (..........)

(b) 1.7 liters (..........)

(c) 11 liters (..........)

(d) 15 liters (..........)

(e) 22 liters (..........)

FOR ROUGH WORK

(No marks given for work in this space)

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Values

5 **40.** What is the volume of 1.5 moles of nitrogen measured over water at 27° C. and a pressure of 730 mm. of Hg? (Vapor pressure of water at 27° C. is 28 mm. of Hg)

5 **41.** What is the molecular weight of a gas whose density at 705 mm. of Hg and 25° C. is 1.67 grams per milliliter?

FOR ROUGH WORK

(No marks given for work in this space)

Values

5 **42.** What pressure is exerted by 0.25 moles of a gas in a 6.0 liter container at 127° C.?

5 **43.** How long would a current of 20 amp. have to be passed through a cell containing molten NaCl to produce 23 grams of metallic sodium at the cathode?

FOR ROUGH WORK

(No marks given for work in this space)

[OVER]

Values

5 **44.** In the synthesis of a compound there are used up 1.26 grams of carbon, 0.240 gram-atom of hydrogen, and 9.01×10^{21} atoms of oxygen. What is the simplest formula of the compound?

2 **45.** (a) A student is testing for anions. He adds a reagent to a solution containing an anion and obtains a white precipitate.

(1) What anion might be present in the solution? ....

(2) What reagent would he use? ....

2 (b) A student took some concentrated HCl from a reagent bottle to clean a platinum wire for a flame test. Even though he dipped the wire repeatedly in this cleaning agent, he continued to get a yellow flame coloration. What can he conclude from this?

....

....

....

4 **46.** Indicate two tests which could be used to distinguish between a strong acid and a weak acid?

....

....

....

....

....

....

Do Not
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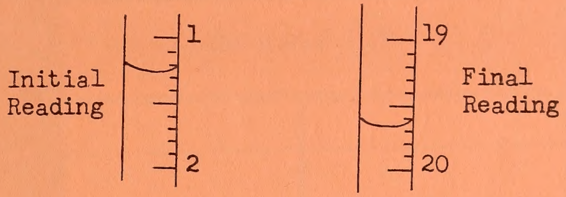
Values

47. The diagram below shows the initial and final burette readings in a titration of 25.0 ml. of 0.206 M HCl with ammonium hyroxide.



5 (a) Calculate the concentration of the ammonium hydroxide to two significant digits.

Equation: $NH_4OH + HCl \longrightarrow NH_4Cl + H_2O$

3 (b) If the tip of the burette contained air at the beginning of the titration but not at the end, would the real concentration of NH_4OH be higher or lower than the answer calculated in No. 47(a). Give your reasoning.

FOR ROUGH WORK

(No marks given for work in this space)

[OVER]

Values

3 **48.** How would you test for the presence of iodide ion in a solution?

✓

3 **49.** How would you test for the presence of lead ion in a solution?

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